30. Note *on the* Carboniferous Conglomerates *of the* Eastern Part *of the* Basin *of the* Eden. By J. G. Goodchild, Esq., H.M. Geological Survey of England and Wales. (Read March 25, 1874.)

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Professor Phillips has pointed out, in his 'Geology of Yorkshire,' that the Mountain-Limestone between the northern border of the Lake-district and the river Eden includes a group of red sandstones, alternating with limestones in the lower part of the series.

They were referred to by him as the "Alternating Limestone and Red Sandstone Series," and were considered to be the passage-beds between the true basement series, or Upper Old Red, and the principal mass of the Mountain-Limestone which forms the comparatively high ground between the basins of the rivers Lune and Eden.

This middle group is fairly exhibited about three miles to the south of Kirkby Stephen, at Ash Fell, where the different members of the whole series may be examined in the quarries and natural sections laid bare in the immediate neighbourhood (fig. 1).

The general sequence in descending order is as follows:—

"*a.*" Principal mass of the Carboniferous Limestone, including a few thin beds of stained sandstone and shale between thick masses of limestone, and having a total thickness of not less than 1000 feet, between Ash Fell and Kirkby Stephen.

"*b.*" Obliquely laminated, soft, red sandstones, here and there very calcareous, generally containing many traces of Coal-measure plants, and frequently assuming a conglomeratic character in consequence of the presence of a few pebbles of milky quartz, and the occurrence of lenticular fragments of now decomposed shale on some of the faces of bedding.

These beds alternate with thin shales, which are usually very full of fossils where calcareous, and with beds of limestone of variable thickness and different degrees of purity.

Near the top of the series these limestones are usually encrinital and crystalline; others are rather earthy and have interlaminated sandy bands; while those nearer the base, although generally pure in the mass, have courses of quartz pebbles up to an inch in diameter on some of the bedding planes.

Here and there amongst the quartz pebbles may be detected pieces of pinkish felspar or fragments of slaty rock, probably of Silurian origin, which suggest by their usually subangular character that the associated quartz was rolled into pebbles ere it began to be drifted into its present position.

The total thickness of this series at Ash Fell is about 500 feet; but the interbedded limestones thin rapidly in a north-westerly direction, so that near Shap the total thickness cannot be much more than 300 feet, which is mostly made up of sandstones more or

Fig. 1.—*Diagram Section from the Howgill Fells to Roman Fell.*

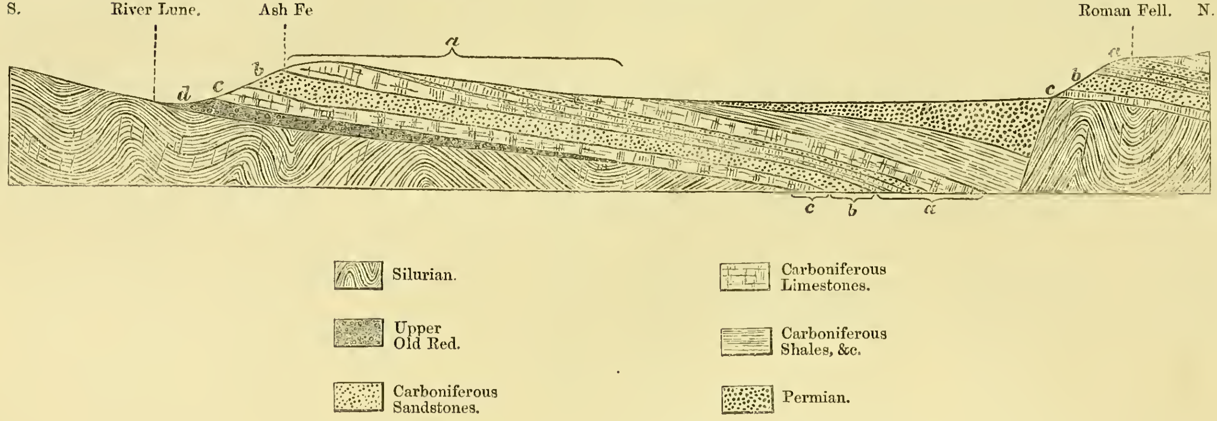
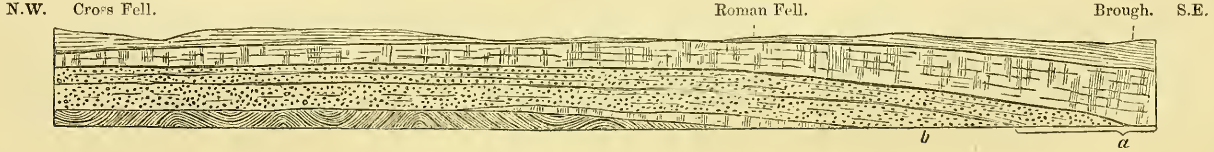

S.
River Lune.
Ash Fe
Roman Fell.
N.
a
d
c
b
c
b
a
c
b
a
▨ Silurian.
▨ Upper Old Red.
▨ Carboniferous Sandstones.
▨ Carboniferous Limestones.
▨ Carboniferous Shales, &c.
▨ Permian.

Fig. 2.—*Diagram Section along the Cross-Fell Escarpment.*



less conglomeratic, and subordinate beds of limestone, which are similar in lithological character to those in the Ash-Fell sections.

Some sandstones about the middle of this series may be seen in the railway-cutting in the village of Shap.

"*c*." The Sandstone series is succeeded by a variable thickness of limestone, which cannot be less than 500 or 600 feet near Ash Fell.

The beds are not usually so pure as those of the upper series; but this lower group is nowhere split up by beds of sandstone or shale. Near the base it becomes thinner-bedded and passes down by almost insensible gradations into the next series.

"*d*." This group in its upper part consists of shales, with thin impure limestones here and there containing grains of quartz, and passes down through calcareous beds of a more decidedly conglomeratic character into a series of apple-green quartz conglomerates and chocolate and grey shales.

These, in their turn, are succeeded without any clear line of demarcation by the Drift-like series of red conglomerates, sandstones, and shales which forms the lower part of the Carboniferous basement-beds here, and has always been considered the equivalent of the Upper Old Red of other parts of the kingdom.

This basement-series is exceedingly variable in thickness and mineral character; and, so far as it has yet been proved, it seems to be mainly composed of locally derived materials.

These are the beds which are seen at intervals along the northern border of the Lake-district between the Silurian rocks and the limestone scars of the Carboniferous series. They are very well exposed in Birk Beck, between Tebay and Shap Wells.

Between Poola Bridge, at the foot of Ullswater, and the village of Dacre are thick masses of roughly stratified conglomerates belonging to this basement-series. It is these beds which form the striking conical hills known as Great Mell Fell and Little Mell Fell, as well as others of the same outline between the foot of Ullswater and the outcrop of the Carboniferous Limestone to the north.

A thickness of several hundred feet of limestone belonging to group "*c*" comes on above the conglomerates in the river-Eamont sections north of Ullswater; and it is not until we reach Yanwath, about two miles to the south of Penrith, that we find the Ash-Fell beds in full force.

Groups "*b*," "*c*," and "*d*" form much of the valley-ground skirting the north-eastern border of the Lake-district; and the generally north-easterly dip of the beds causes these lower groups to pass beneath the higher members of the Carboniferous series and the Permian rocks up to the great lines of disturbance at the foot of the Pennine escarpment, where they are again thrown up to the surface by faults which have several thousand feet of downthrow on the south side.

About a mile and a half to the east of Ash Fell a north-easterly line of disturbance cuts off the Ash-Fell beds on the east, and throws in limestones belonging to the series "*a*."

The strike of the beds on the western side of the faults continues nearly parallel to the lines of disturbance from near Ash Fell, northward along the foot of Stainmoor, to the Cross-Fell escarpment (fig. 2, p. 395); so that limestones belonging to the higher part of "*a*" are not lost sight of for any great distance, but may be traced round to the perfectly clear section in the scars above Brough, where the principal bed of this series is recognized as the Melmerby-Scar Limestone.

This is the bed which forms, with the Whin Sill, the more striking and picturesque features of the Carboniferous rocks on the upcast side of the Pennine faults.

A little to the west of Brough the generally north-easterly dip of the beds on the north side of the lines of disturbance brings up from beneath the Melmerby-Scar Limestone a series of sandstones of various degrees of coarseness interbedded with shales and beds of impure limestone.

These are clearly seen to overlie a group of conglomerates, gannister-like sandstones with Coal-measure plants, and subordinate beds of sandy limestone containing many courses of well-rolled pebbles of quartz.

This conglomeratic series is succeeded by a mass of grey limestone, the thickness of which cannot be made out in the typical sections.

These beds, from the Melmerby-Scar Limestone downwards, correspond so closely in lithological character and geological position with the beds seen south of Kirkby Stephen that there is little room left for doubt as to their identity.

The sandstone and impure limestone series next below the Melmerby-Scar Limestone probably represents the lower part of group "*a*," which was described as being split up by thin beds of sandstone and shale.

It must be admitted that the interbedded limestones in this sandstone group in the escarpment are rarely found to be thicker than 25 or 30 feet, while those on what is supposed to be the same horizon south of Kirkby Stephen have a thickness of from 100 to 150 feet between the partings of sandstone.

As there is a distance of a little more than eight miles between the two lines of outcrop, few geologists accustomed to follow individual beds over long distances will feel inclined to lay much stress on the difference in thickness of the limestones in the two sections, when the thinning can be shown to be at the rate of only 15 feet in a mile. As an additional argument in favour of the identity, at least in part, of the escarpment-sandstone and thin limestone series with the limestone group "*a*" south of Kirkby Stephen, it may be mentioned that the thin beds of sandstone observed in the limestone series "*a*" north of Ash Fell are found to thicken and the associated beds of limestone to diminish in thickness, and become still further split up by sandstones and shales, as they are followed in a north-westerly direction towards Penrith.

If it were possible to follow these beds under the Permians still further to the north-west, we should probably find that the limestones had become quite subordinate to the sandstone series, and that there would be little, if any, noticeable difference, except that of colour, between these beds and the rocks below the Melmerby-Scar limestone at the eastern end of the Cross-Fell escarpment.

The conglomerate series next in order, notwithstanding its superficial resemblance in lithological character to the conglomerates of the basement-series, as seen at the foot of Ullswater, is distinguished from them by its including thin beds of limestone; and we should probably not err in referring this part of the series to beds about the horizon of the Ash-Fell beds "*b*."

The mass of grey limestone on which the conglomerates lie occupies the relative position of the limestone group "*c*," beneath the Ash-Fell beds, and probably is wholly or in part identical with it.

The base of the series is not clearly seen in the typical section in the escarpment; but, as in an adjoining section the conglomerates are clearly seen to be at no great distance from the floor of Silurian rocks upon which the Carboniferous beds lie, there cannot be any great thickness of this lower limestone.

Perhaps the only other distinction of any note between the beds seen in the escarpment and those along their southern outcrop about Ash Fell lies in the fact that the very well-marked red tint which is seen in the Ash-Fell sandstones is nearly or quite absent in the beds under the Melmerby-Scar limestone.

But as other sandstones higher in the series, which are red on the downthrown side of the great faults, are clearly seen to be of their natural colour on the upthrown side, it is inferred that the staining is due to Permian influence; and the mere absence of the red tint is therefore not a distinction of any value.

In my opinion this marked absence of staining in the Carboniferous beds on the escarpment sides of the great lines of disturbance is due to a considerable upheaval in late geological times, the plain upon which the Permian rocks once rested being now only in part represented by the tops of the highest fells on the north side of the Pennine faults.

Perhaps there is no place along the Cross-Fell escarpment where this group of sandstones and conglomerates can be so well examined, and its relation to the beds above and below so clearly made out, as on Roman Fell and in the scars to the south-east of it.

Along other parts of the escarpment, much of the lower slopes along which these beds mostly occur is obscured by drift and by fallen blocks from the scars above.

It will therefore be convenient to speak of the whole series between the base of the Melmerby-Scar limestone and the top of the lowest thick limestone as the Roman-Fell beds.

This group will therefore include not only the supposed representatives of the Ash-Fell beds "*b*," but also the lower part of the Limestone series, indicated by the letter "*a*" in the diagram section at Ash Fell (fig. 1).

In following the outcrop of the Roman-Fell beds towards Cumberland, the conglomeratic beds from the middle of the group downwards are found to increase much in thickness, and the included stones to become so much larger that there is little difficulty in finding masses of quartz nine inches or a foot in diameter in some of the coarser beds.

The upper part of the group, between the conglomerates and the Melmerby-Scar limestone, does not seem so changeable: except that the interbedded limestones are thinner and usually of a lesser degree of purity, and that coals set in to the north, there is but little difference between these beds under Cross Fell and their eastward extension as seen near Brough.

As has already been remarked of some of the limestones associated with the Ash-Fell beds on the south side of the great faults, the beds above and below the Roman-Fell series become much thinner in a north-westerly direction, so that under Cross Fell the Melmerby-Scar limestone is little more than half as thick as the same bed at Brough; and there is reason for believing that the lower limestone, which is seen under the Roman-Fell beds near Brough, dies away completely before we reach Cumberland.

The exact point where it does so cannot be indicated until a more detailed examination of the ground has been made.

So far as the writer has been able to make out in his holiday rambles, there does not appear to be any undoubted equivalent of the true Carboniferous basement-series along the escarpment, although it is possible that those beds may be feebly represented in places by the lower part of the conglomerates.

The tendency to become coarser in a north-westerly direction is not so marked along the southern outcrop of the Ash-Fell beds, so far as they have yet been traced into the basin of the Eden; but at a short distance west of Penrith some sandstone beds, which must be very near this horizon, are quite as coarse as any millstone grit, and in themselves could not be distinguished from it.

Over a considerable area to the east and north of the Silurian rocks of the Lake-district one of the results of the Geological Survey has been to prove that, as a rule, the limestones of the Carboniferous series increase in thickness towards the south-east, and that, on the other hand, the purely drifted deposits come on in greater force, and generally tend to increase in coarseness, in proportion as they are followed towards the north-west.

As this rule can thus be shown to be one of wide application in the higher parts of the series, one may infer that these lower beds form no exception, but that the whole of the lower part of the Carboniferous series tends to assume more and more of a littoral character as it is followed towards the north-west, and that any of the limestones which can be shown to have died away along the escarpment will not be found to reappear along the northern outcrops of the local base of the carboniferous rocks, but that these Roman-Fell beds over large areas will be found to rest directly upon the older rocks wherever there are no intervening patches of "Old Red."

We should perhaps not be far wrong in considering that these Roman Fell beds are about the horizon of the Calciferous Sandstone series of the south of Scotland. If one may judge by the published descriptions, there is a close agreement between them both in lithological character and in their position in the Carboniferous series[*].

From what has been stated it would therefore appear that certain beds, which can be shown to occur about the middle of the Carboniferous Limestone in one part of Westmoreland, develop into coarse conglomerates, which are locally undistinguishable from much of the true basement series, and have been described, by authors who have not had opportunities of tracing out the true position of these beds in the Carboniferous series, as undoubted Old Red Sandstone.

Discussion.

Prof. Hughes confirmed the observations of Mr. Goodchild, and showed their importance as bearing upon inquiries into the changes of the land which furnished, and of the currents which arranged, the materials of the beds described.

Prof. Ramsay remarked that the author was entitled to much praise for the manner in which he had worked out the minor details of the Carboniferous system. The Cross-Fell conglomerates had been called Old Red Sandstone; they are now placed in the Lower Carboniferous, but no distinct line of demarcation can be determined. Prof. Ramsay remarked on the distribution of deposits of the Carboniferous series in Britain, and referred especially to the Carboniferous Limestone. In the south of Pembroke and Glamorganshire this formation is 2500 or 3000 feet thick; in the Devonshire area 100 feet, and in the north of Glamorganshire 500–600 feet represent the whole of the Mountain-Limestone; in Coalbrook Dale, again, its thickness is only about 100 feet, in North Wales 800 feet, in Anglesea 500 feet. In advancing towards Palæozoic districts, where old land existed, the limestone becomes thin, whilst it becomes thick in the deep-water areas,—in Derbyshire 3000–4000 feet, falling off to less than 1000 feet in Cumberland, where it is split up by sandstones; and this is still more strikingly the case in Scotland, where 100 feet of limestone is a rarity. He thought the existence of coral reefs in the Mountain-Limestone doubtful.

Mr. Tiddeman remarked that the Mountain-Limestone was 3000 or 4000 feet thick in the Lake-district, and in the Pennine Chain, at a distance of 15 miles, only 600 feet.

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[*] The writer wishes it to be stated that he had independently arrived at this conclusion before he heard that Mr. James Geikie held similar views regarding these Roman-Fell beds.